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DESCRIPTION OF A ROCK-DWELLING CICHLID (TELEOSTEI: CICHLIDAE) FROM LAKE MALAWI, AFRICA

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Abstract.—A new species of cichlid fish of the *Pseudotropheus zebra* complex, *P. xanstomachus,* is described from Lake Malawi, Africa. The species is endemic to the Maleri Islands. The species is morphologically similar to the sympatric *Pseudotropheus barlow* McKaye & Stauffer, but the species are distinguishable in both coloration and shape.

The rock-dwelling cichlids ("mbuna") which inhabit the rocky shores and rock outcroppings of Lake Malawi are represented by many species which are endemic to particular islands. Ribbink et al. (1983) published a survey of this group and Lewis et al. (1986) published a guide to the fishes of the Lake Malawi National Park, which discussed the distribution of many of the mbuna. The purpose of this paper is to describe a new species closely related to *Pseudotropheus zebra* (Boulenger) endemic to a group of islands collectively referred to as the Maleri Islands, located in Lake Malawi, Malawi, Africa. Ribbink et al. (1983) recognized this form and referred to it as *P. zebra* "yellow throat."

Methods and materials.—Standard length (SL) is used throughout. External counts and measurements follow Barel et al. (1977). Scale counts in the lateral line series do not include scales in the overlapping portion of the lower lateral line. Except for gill raker meristics, which were recorded from the right side, all counts and measurements were made on the left side of the fish. Vertebral counts were made from radiographs. All specimens were collected at Nakantenga Island (34°39′E, 13°55′S), Lake Malawi, Africa (Apr 1984 and Aug 1987).

The new species is compared with *P. barlowi* by color descriptions of fresh specimens, meristic differences, and shape differences. Body shape differences were compared using sheared principal component analysis (Humphries et al. 1981, Bookstein et al. 1985). This analysis quantifies shape differences between the two populations independent of size of the individuals (Reyment et al. 1984).

Pseudotropheus xanstomachus, new species

Figs. 1, 2; Tables 1, 2

Pseudotropheus zebra, Ribbink et al., 1983: 162 (in part).

Holotype.—National Museum of Natural History (USNM) 297268, adult male, 63.3 mm, Nakantenga Island, Lake Malawi, 3–7 m, 4 Aug 1987.

Paratypes.—USNM 297269, 11 (47.0–70.8 mm), data as for holotype; USNM 297270, 4 (63.5–78.5 mm), Nakantenga Island, Lake Malawi, 12 m, 19 Apr 1984.

Diagnosis.—This species fits the description of the genus *Pseudotropheus* as given by Regan (1921) in that: 1) its jaws have several rows of teeth, with the ones in the outer row bicuspid and those in the inner rows tricuspid; 2) it has 16–18 dorsal-fin spines, 7–8 dorsal-fin rays, 3 anal-fin spines, and 6–7 anal-fin rays. However, as noted by Ribbink et al. (1983), Fryer (1957:350) regarded the genus *Pseudotropheus* as being "rather ill-defined." *Pseudotropheus xan-*

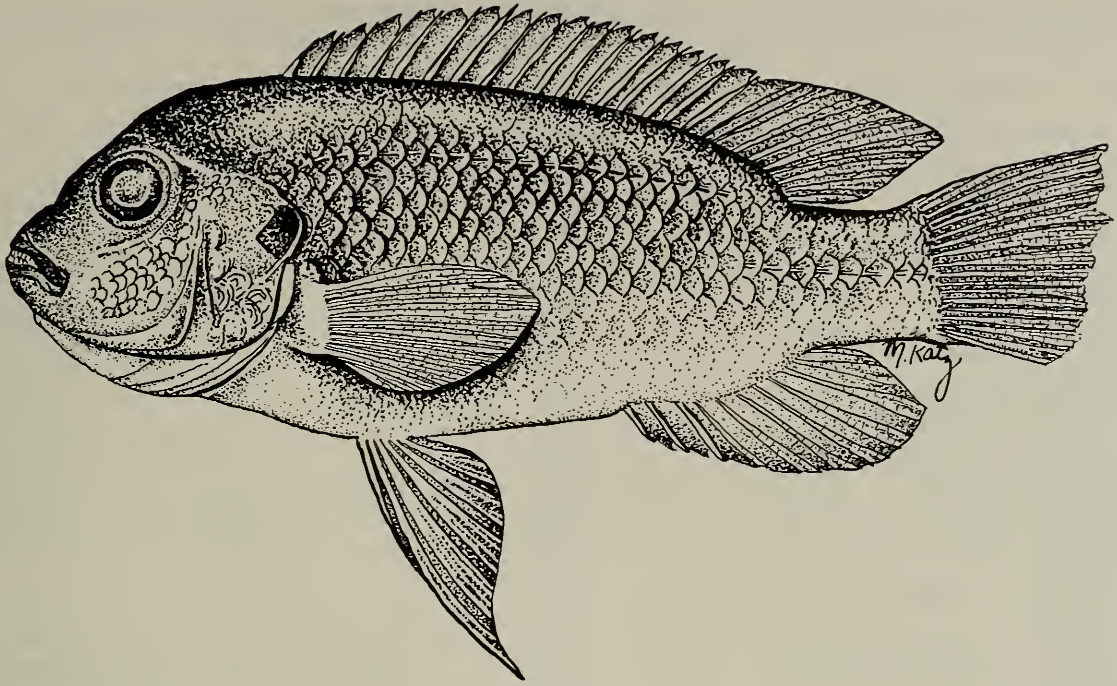
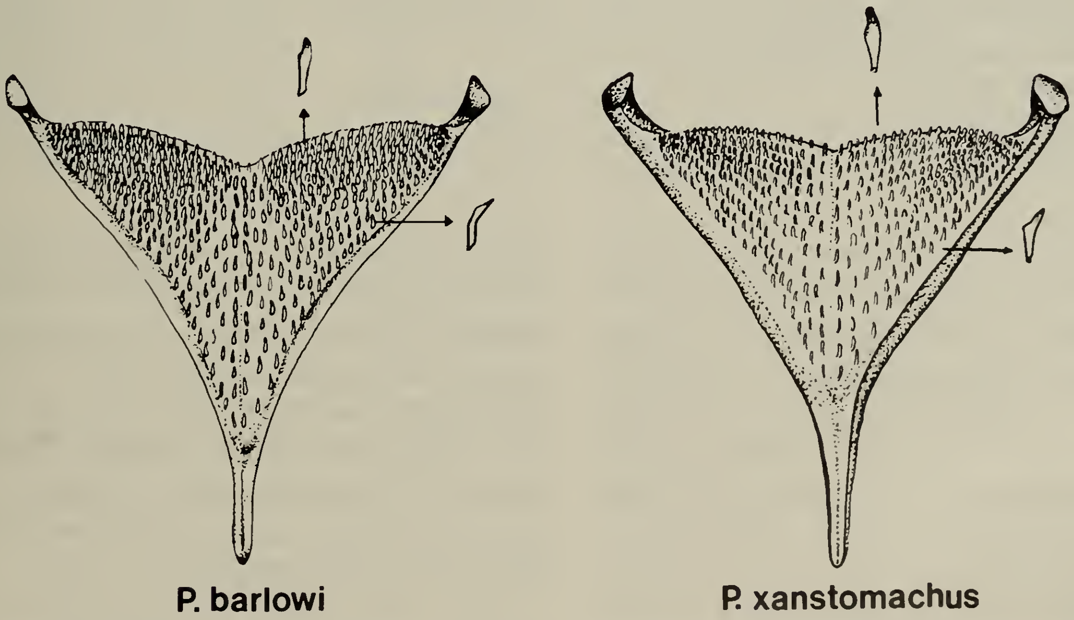


Fig. 1. Holotype (USNM 297268) of *Pseudotropheus xanstomachus.*

stomachus differs from other members of the group in coloration. It differs from the only described sympatric member of the group in the number of anal-fin rays, shape of the lower pharyngeal bone, the length of the dentigerous surface of the lower pharyngeal bone, and in body shape.

Description.—Morphometric ratios and meristics are presented in Table 1. Body moderately compressed and elongate; jaws isognathous (Fig. 1). Teeth on lower jaw in 3–4 rows, those on premaxilla in 4 rows; teeth in outer rows bicuspid, with occasional conical lateral tooth in some individuals; teeth in inner rows tricuspid; 12 teeth in outer row of left lower jaw of holotype, 9–



P. barlowi

P. xanstomachus

Fig. 2. Lower pharyngeal bones of the holotypes of *Pseudotropheus barlowi* and *Pseudotropheus xanstomachus.*

Table 1.—Morphometric characters and meristics of *Pseudotropheus xanstomachus*. Range includes holotype and 15 paratypes.

	Holotype	Mean	SD	Range
Standard length, mm	63.3	62.9	7.1	47.0–78.5
Head length, mm	20.5	20.4	2.4	15.3–26.0
Percent Standard Length				
Head length	32.4	32.4	0.7	31.5–33.4
Snout to dorsal	32.2	33.3	1.2	30.9–35.0
Snout to pelvic	43.4	43.1	1.3	40.8–45.2
Greatest Body depth	36.7	34.2	1.4	31.8–36.5
Caudal peduncle length	12.8	13.5	1.3	11.2–15.5
Least caudal peduncle depth	13.0	12.9	0.3	12.3–13.4
Pectoral-fin length	26.5	25.6	1.8	22.4–28.2
Pelvic-fin length	31.8	27.7	4.5	21.6–36.4
Dorsal-fin base length	60.7	60.4	1.1	58.6–62.2
Percent Head Length				
Horizontal eye diameter	30.7	31.3	1.1	28.5–32.8
Vertical eye diameter	30.2	30.9	1.3	28.1–33.3
Snout length	33.7	35.1	1.4	33.2–37.7
Postorbital head length	40.5	40.0	0.8	38.5–41.2
Preorbital depth	21.5	20.3	1.2	18.2–22.6
Lower jaw length	34.6	33.6	1.2	32.0–36.5
Interorbital width	28.3	28.3	2.4	25.3–33.6
Cheek depth	30.2	30.0	2.8	24.5–34.4
Head depth	98.5	95.1	3.0	91.1–100.1
Counts				
Lateral line scales	30	29.9	0.5	29–31
Scale rows on cheek	5	5.4	0.5	5–6
Dorsal-fin spines	17	17.1	0.5	16–18
Dorsal-fin rays	8	7.9	0.4	7–8
Pectoral-fin rays	13	13.3	1.0	10–14
Anal-fin rays	7	6.9	0.3	6–7
Gillrakers on first ceratobranchial	12	10.8	0.9	9–12
Gillrakers on first epibranchial	3	2.5	0.5	2–3
Teeth in outer row of left lower jaw	12	10.7	1.1	9–12
Abdominal vertebrae	14	13.6	0.8	12–15
Caudal vertebrae	14	14.7	0.5	14–15

12 in paratyes. Pectoral fins with 13 rays in holotype and 10–14 in paratypes; anal fin with 7 rays in holotype and 6–7 in paratypes; caudal fin emarginate. Vertebrae of holotype 14 + 14 (abdominal + caudal); paratypes 12–14 + 14–15. Lower pharyngeal bone of holotype triangular in outline, length of dentigerous surface 59% of lower pharyngeal bone length; pharyngeal teeth in left posterior row 23, those in left median row, 13. Holotype with 5 scale rows on cheek, paratypes with 5–6; pored scales along lateral line of holotype 30, and of paratypes 29–31; pored scales posterior to hypural plate 2, with exception of two paratypes which had scales missing from this area. Gill rakers simple, first gill arch of holotype with 12 on ceratobranchial (9–12 in paratypes); 3 on epibranchial of holotype and 2–3 in paratypes; and 1 between epibranchial and ceratobranchial.

Body coloration in freshly collected males light blue with six black vertical bars; head dark blue with one light blue interorbital

Table 2.—Sheared principal components (shape factors) of the untransformed morphometric data for *Pseudotropheus xanstomachus* (n = 16) and *Pseudotropheus barlowi* (n = 10).

		Sheared	
	Size	PC 2	PC 3
Standard length	0.215	−0.021	−0.082
Head length	0.207	−0.011	−0.108
Horizontal eye diameter	0.183	0.095	−0.154
Vertical eye diameter	0.189	0.048	−0.048
Snout length	0.231	−0.088	−0.225
Postorbital head length	0.193	−0.107	−0.048
Preorbital depth	0.282	−0.117	0.042
Lower jaw length	0.210	0.070	−0.048
Interorbital width	0.275	−0.065	−0.014
Snout to dorsal fin origin	0.212	0.052	−0.149
Snout to pelvic fin origin	0.261	−0.064	−0.137
Body depth	0.231	0.136	−0.050
Cheek depth	0.169	−0.594	0.447
Head depth	0.229	0.010	−0.067
Caudal peduncle length	0.219	−0.459	0.206
Least caudal peduncle depth	0.215	0.048	−0.050
Pectoral-fin length	0.258	0.155	−0.158
Pelvic-fin length	0.311	0.521	0.728
Dorsal-fin base length	0.215	−0.009	−0.069

bar, yellow gular and branchiostegal rays; dorsal fin medium blue with grey flecks and light blue marginal band; pectoral fins black; pelvic fins black anteriorly fading to yellow-brown posteriorly; anal fin blue; males with three to five yellow ocelli on anal fin. Body coloration of females similar, but some individuals have light brown body coloration with brownish cast to fins.

The description of the coloration and the color plate of the males in Ribbink et al. (1983:162; plate 2a) agree with the above description, except that they noted between 1–5 ocelli on the anal fin. Ribbink et al. (1983:162) note that the females are "dark brown sometimes almost black with darker bars . . . ." The differences in color of the females may be associated with breeding coloration and may be influenced by the time of the year when the fish were observed. However, all descriptions of the female coloration note a yellow chin and gular region.

Etymology.—The specific epithet is derived from the Greek "xanthos" and "stomachus" meaning yellow throat, which characterizes the yellow gular region present in both sexes.

Discussion.—*Pseudotropheus xanstomachus* is morphologically similar to the *P. zebra* complex in that it has a terminal mouth, has three or four rows of teeth, of which the outer rows are bicuspid, with the occasional conical lateral tooth, and the inner rows are tricuspid (see Ribbink et al. 1983). The only sympatric species of this complex which is described is *P. barlowi,* from which *P. xanstomachus* differs in coloration. *P. barlowi* males are bright gold, and the females are uniformly brown (McKaye & Stauffer 1986). Differences in color patterns among cichlids, especially the male's, generally are recognized to be sufficient to delimit valid species (Greenwood 1981, Hoogerhoud & Witte 1981).

In addition to coloration differences, *P. xanstomachus* has six or seven anal rays while *P. barlowi* has eight. The shape of the lower pharyngeal bone between the two species also differs. The angle of the suture

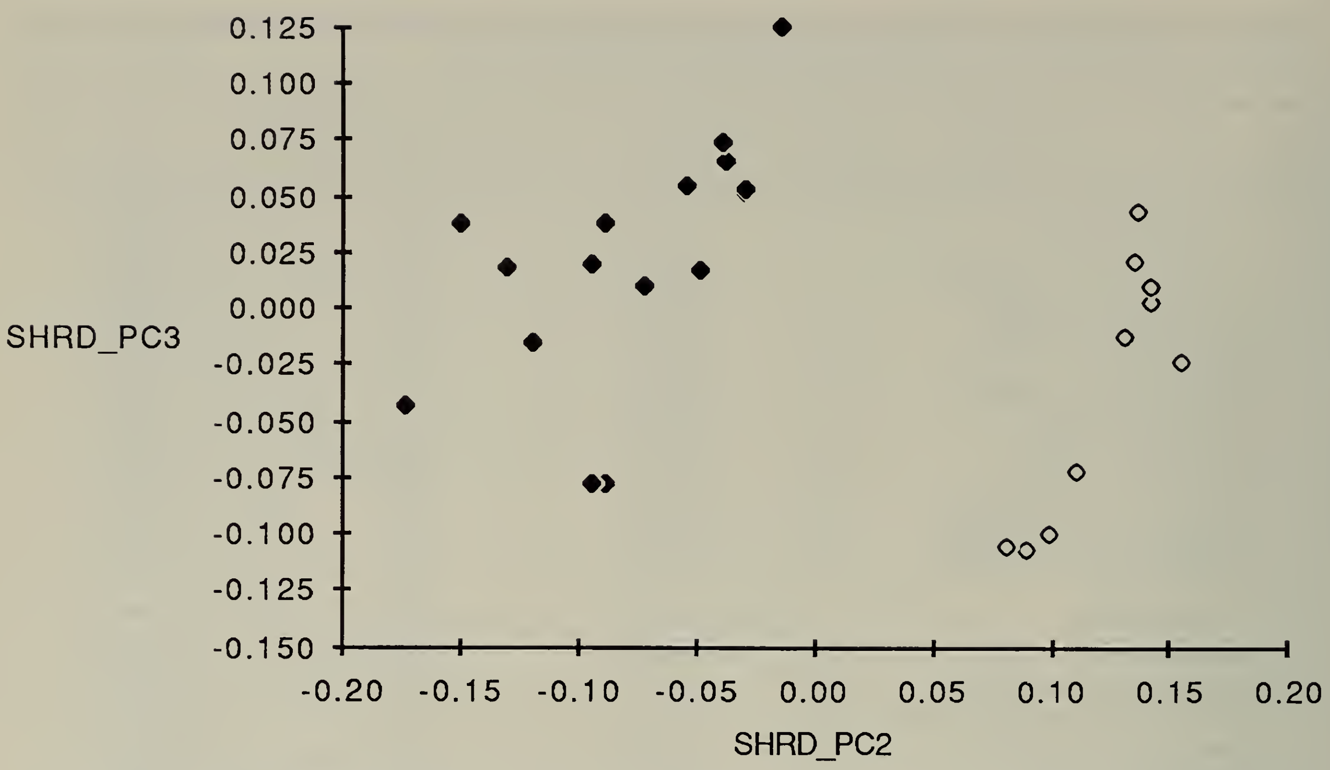


Fig. 3. Plot of the sheared principal components of *Pseudotropheus xanstomachus* (solid) and *Pseudotropheus barlowi* (open).

of the two posterior halves of the lower pharyngeal bone is more acute and the resultant depression is greater in *P. barlowi* (Fig. 2). Moreover, the length of the dentigerous surface of the lower pharyngeal bone of *P. barlowi* was 76% (range = 74–78%) of the length of the bone (n = 3; USNM 274782; USNM 274783), while the length of the dentigerous surface of the lower pharyngeal bone of *P. xanstomachus* was 62% (n = 4; range = 57–67%).

An attempt was made to determine if there were differences in body shape between the two described sympatric species of the *P. zebra* complex using a sheared principal component analysis. Data for *P. barlowi* were obtained from the original data sheets used by McKaye & Stauffer (1986). Sheared principal component analysis demonstrated that there was no overlap between species when the first sheared principal component was plotted against the second sheared principal component (Fig. 3). The first principal component is interpreted as a size component and the sheared components as shape, independent of size (see Humphries et al. 1981, Bookstein et al. 1985). Thus, these data were calculated using the untransformed values of the morphometrics rather than percent standard length or percent head length. Those morphometrics which have the highest loadings on the first sheared principal component are cheek depth, pelvic-fin length, and caudal peduncle length, while those which have the highest loadings on the second sheared principal component are pelvic-fin length, cheek depth, and snout length (Table 2).

All of the specimens reported herein were captured at a depth between 7–12 m at Nakantenga Island. Ribbink et al. (1983) reported this form from all three Maleri Islands: Namkoma, Maleri, and Nakantenga. They stated that it was most common between depths of 2–8 m, and was rare in water deeper than 12 m. Conversely, McKaye & Stauffer (1986) stated that *P. barlowi* occurred primarily at depths greater than 10 m and hypothesized that the occurrence of these brightly colored forms in deeper water may be an adaptation related to avoidance of surface predators (i.e., birds and otters). Therefore, even though *P. xanstomachus* and *P. barlowi* are indigenous to the same islands, they are in effect allotopic.

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